## WE CLAIM:

1. A method of forming a silicon-containing compound layer in an integrated circuit, the method comprising a plurality of cycles, each cycle comprising:

depositing a silicon layer on a substrate in a process chamber by exposing the substrate to trisilane;

substantially removing the trisilane from the process chamber;

forming a silicon-containing compound layer by exposing the silicon layer to a reactive species; and

substantially removing the reactive species from the process chamber.

- 2. The method of Claim 1, wherein the reaction chamber is a single substrate laminar flow reaction chamber.
  - 3. The method of Claim 1, wherein the reaction chamber is a batch reactor.
- 4. The method of Claim 1, wherein depositing a silicon layer comprises chemical vapor deposition.
- 5. The method of Claim 1, wherein depositing the silicon layer comprises forming more than one atomic layer of silicon.
- 6. The method of Claim 1, wherein the reactive species comprises a nitrogen species and the silicon-containing compound layer comprises silicon nitride.
  - 7. The method of Claim 6, wherein the nitrogen species comprises ammonia.
- 8. The method of Claim 6, wherein the nitrogen species comprises nitrogen active species.
- 9. The method of Claim 6, wherein the silicon nitride layer is more uniform than a silicon nitride layer of substantially similar thickness deposited by chemical vapor deposition with silane.
- 10. The method of Claim 6, wherein the silicon nitride layer is formed over an interfacial layer.
- 11. The method of Claim 10, wherein the interfacial layer comprises silicon oxynitride.
  - 12. The method of Claim 10, wherein the interfacial layer comprises silicon oxide.

- 13. The method of Claim 10, wherein the interfacial layer is formed by thermal oxidation.
- 14. The method of Claim 10, wherein the interfacial layer is formed by a process comprising:

depositing a silicon layer on a substrate by exposing the substrate to trisilane; and

forming the interfacial layer by exposing the silicon layer to an oxygen species.

- 15. The method of Claim 14, wherein the oxygen species comprises one or more oxidants selected from the group consisting of atomic oxygen, water, ozone, oxygen, nitric oxide, and nitrous oxide.
- 16. The method of Claim 1, wherein the silicon-containing compound layer is formed over a hydrogen passivated substrate.
- 17. The method of Claim 1, wherein substantially removing the trisilane comprises a removal process chosen from the group consisting of evacuating the process chamber and purging the process chamber with inert gas.
- 18. The method of Claim 1, wherein substantially removing the reactive species comprises a removal process chosen from the group consisting of evacuating the reactive species and purging the process chamber with inert gas.
- 19. The method of Claim 1, wherein the cycles are repeated until the silicon-containing compound layer has a thickness between about 3 Å and 5000 Å.
- 20. The method of Claim 19, wherein the cycles are repeated until the thickness is between about 3 Å and 400 Å.
- 21. The method of Claim 1, wherein the silicon-containing compound layer has a thickness non-uniformity of about 5% or less.
- 22. The method of Claim 21, wherein the silicon-containing compound layer has a step coverage of about 80% or greater.
  - 23. A method of forming an insulating film, comprising: loading a substrate into a reaction chamber;

forming a silicon film by exposing the substrate to a silicon source, wherein the silicon source for forming a first silicon film on the substrate, after loading the substrate, is a polysilane;

substantially removing the silicon source from the reaction chamber; exposing the silicon film to a nitrogen source to form a silicon nitride film; and

substantially removing the nitrogen source from the reaction chamber.

- 24. The method of Claim 23, wherein the silicon source comprises one or more compounds selected from the group consisting of disilane and trisilane.
- 25. The method of Claim 24, further comprising augmenting a silicon nitride film thickness by forming a silicon nitride layer directly over the silicon nitride film by a further CVD process in which silicon and nitrogen precursors are simultaneously introduced into the reaction chamber.
- 26. The method of Claim 25, further comprising forming a silicon nitride sealing layer directly over the further silicon nitride layer, wherein the silicon nitride sealing layer is formed by a method comprising:

forming a silicon layer by exposing the substrate to a silicon source comprising trisilane;

substantially removing the silicon source from the reaction chamber; exposing the silicon layer to a nitrogen source; and substantially removing the nitrogen source from the reaction chamber.

- 27. The method of Claim 23, wherein forming a silicon film, substantially removing the silicon source, exposing the silicon film to a nitrogen source, and substantially removing the nitrogen source are repeated in sequence until a silicon nitride film of a desired thickness is formed.
- 28. The method of Claim 27, wherein the silicon source for forming silicon films after forming a first silicon film comprises a compound having a chemical formula  $Si_nH_{2n+2}$ , wherein n is equal to a number from 1 to 4.
- 29. The method of Claim 27, wherein a halosilane replaces trisilane as the silicon source after a first silicon film is formed.

- 30. The method of Claim 23, wherein the first silicon film has a thickness of at least about a nitridation saturation depth.
- 31. The method of Claim 30, wherein the nitridation saturation depth is a short-term nitridation saturation depth.
- 32. The method of Claim 30, wherein the nitridation saturation depth is between about 3 Å and 30 Å.
- 33. The method of Claim 23, wherein a ratio of silicon atoms and nitrogen atoms comprising the silicon nitride film is substantially stoichiometric.
- 34. The method of Claim 33, wherein the silicon nitride film has less than about 0.2 atomic percent incorporated hydrogen.
- 35. The method of Claim 34, wherein the silicon nitride film has less leakage current than a similar silicon nitride film formed by a CVD process in which silicon and nitrogen precursors are simultaneously introduced into the reaction chamber.
- 36. The method of Claim 23, wherein the silicon nitride film has a higher dielectric constant than another silicon nitride film deposited by a CVD process in which silicon and nitrogen precursors are simultaneously introduced into the reaction chamber.
- 37. The method of Claim 23, wherein forming a silicon film comprises decomposing the silicon source to form the silicon film with a thickness non-uniformity of about 10 percent or less and a step coverage of about 70% or greater.
- 38. A method of forming a layer, of an insulating silicon compound, having a desired thickness for an integrated circuit by performing multiple chemical vapor deposition cycles in a reaction chamber, each cycle comprising:

first, depositing a silicon layer on a substrate by exposing the substrate to a silicon source, wherein the silicon layer has a silicon layer thickness between about 3 Å and 25 Å; and

second, reacting the silicon layer to partially form the layer of an insulating silicon compound, wherein a temperature for reacting is less than about 650°C.

39. The method of Claim 38, wherein reacting comprises nitriding and wherein the insulating silicon compound is silicon nitride.

- 40. The method of Claim 39, wherein the layer of an insulating silicon compound has a stoichiometry of about 43 silicon atoms per 56 nitrogen atoms.
- 41. The method of Claim 38, wherein reacting comprises oxidizing and wherein the insulating silicon compound is silicon oxide.
- 42. The method of Claim 38, wherein trisilane is the silicon source used to deposit a first silicon layer on the substrate in a first performance of a cycle.
- 43. The method of Claim 42, wherein the silicon source for depositing subsequent silicon layers after depositing the first silicon layer comprises a silicon compound selected from the group consisting of silanes having a silane chemical formula  $Si_nH_{2n+2}$ , where n = 1 to 4, and halosilanes having a halosilane chemical formula  $R_{4-X}SiH_X$ , where R = Cl, Br or I and X = 0 to 3.
- 44. The method of Claim 43, wherein all silicon layers deposited after the first silicon layer are formed with the same silicon source.
- 45. The method of Claim 43, wherein a first substrate temperature for depositing the first silicon layer is less than about 525°C.
- 46. The method of Claim 45, wherein the first substrate temperature is less than about 475°C.
- 47. The method of Claim 46, wherein a second substrate temperature for reacting the first silicon layer is greater than the first substrate temperature.
- 48. The method of Claim 47, wherein depositing and reacting are performed isothermally after reacting the first silicon layer.
- 49. The method of Claim 48, wherein a third substrate temperature for depositing and reacting, after reacting the first silicon layer, is between about 400°C and 650°C.
- 50. The method of Claim 49, wherein the third substrate temperature is greater than about 525°C.
- 51. The method of Claim 47, further comprising evacuating the reaction chamber for at least about 10 seconds before reacting the first silicon layer.
- 52. The method of Claim 47, wherein the first silicon layer has a first silicon layer thickness of about 8-12 Å.

- 53. The method of Claim 52, wherein a temperature and a duration for reacting are chosen to prevent reacting the substrate under the silicon layer.
- 54. The method of Claim 52, wherein reacting the silicon layer comprises exposing the silicon layer to an atomic species.
  - 55. The method of Claim 54, wherein the atomic species is atomic nitrogen.
- 56. The method of Claim 38, wherein the reaction chamber is a single substrate laminar flow reaction chamber.
  - 57. The method of Claim 38, wherein the reaction chamber is a batch reactor.
  - 58. A process of forming a silicon nitride layer on a substrate, comprising:

loading a substrate having a crystalline silicon surface into a single substrate laminar flow process chamber;

forming a silicon layer on the crystalline silicon surface by decomposing a silicon source comprising a polysilane, wherein the polysilane has a chemical formula  $Si_nH_{2n+2}$ , where n=2 to 4;

nitriding the silicon layer to form a silicon nitride layer by flowing a nitrogen source into the process chamber after forming the silicon layer; and

repeating forming a silicon layer and nitriding the silicon layer until a silicon nitride layer of between about 3 Å and 1000 Å thick results.

- 59. The process of Claim 58, wherein forming the silicon layer occurs substantially while the process chamber is substantially free of a precursor used for nitriding the silicon layer and wherein nitriding the silicon layer occurs substantially while the process chamber is substantially free of the polysilane.
  - 60. The process of Claim 58, wherein the silicon source comprises trisilane.
- 61. The process of Claim 60, wherein forming a silicon layer comprises depositing trisilane within a mass transport limited regime.
- 62. The process of Claim 58, further comprising making the process chamber substantially free of the silicon source by evacuating the process chamber directly after forming a silicon layer.

- 63. The process of Claim 58, further comprising making the process chamber substantially free of the silicon source by purging the process chamber directly after forming a silicon layer.
- 64. The process of Claim 58, further comprising making the process chamber substantially free of the silicon source by flowing the nitrogen source into the process chamber directly after forming a silicon layer.
- 65. The process of Claim 58, further comprising making the process chamber substantially free of the nitrogen source by flowing the silicon source into the process chamber directly after forming a silicon layer.
- 66. The process of Claim 58, wherein a first silicon layer formed by decomposing the silicon source has a thickness of at least about a nitridation saturation depth.
- 67. The process of Claim 58, wherein nitriding the silicon layer leaves the crystalline silicon surface substantially free of nitrogen.
- 68. The process of Claim 58, wherein a substrate temperature is between about 400°C and 750°C.
- 69. The process of Claim 68, wherein the substrate temperature is between about 450°C and 650°C.
- 70. The process of Claim 68, wherein depositing and forming are performed isothermally.
- 71. The process of Claim 68, wherein a process chamber pressure is between about 0.001 Torr and 100 Torr.
- 72. The process of Claim 71, wherein a process chamber pressure is between about 0.01 Torr and 10 Torr.
- 73. The process of Claim 71, wherein depositing and forming are performed isobarically.
- 74. The process of Claim 58, wherein a hydrogen concentration of the silicon nitride layer is less than about 0.2 atomic percent.
- 75. The process of Claim 58, further comprising forming a gate electrode over the silicon nitride layer.
  - 76. A method of forming a silicon nitride film, comprising:

loading a substrate into a reaction chamber;

chemical vapor depositing a silicon layer on the substrate, wherein the silicon layer has a thickness non-uniformity of about 5% or less and a height of a top surface of the silicon layer over the substrate is greater than about a nitridation satuaration depth; and

nitriding the silicon layer.

- 77. The method of Claim 76, wherein chemical vapor depositing a silicon layer and nitriding the silicon layer are sequentially repeated until a silicon nitride film of a desired thickness results.
- 78. The method of Claim 77, wherein chemical vapor depositing occurs while the reaction chamber is substantially free of a second precursor used for nitriding and wherein nitriding occurs while the reaction chamber is substantially free of a first precursor used for depositing.
- 79. The method of Claim 76, wherein chemical vapor depositing is performed using a silicon precursor having a chemical formula  $Si_nH_{2n+2}$ , where n=2 to 4.
  - 80. The method of Claim 79, wherein the silicon precursor is trisilane.
- 81. The method of Claim 76, wherein the silicon layer has a thickness non-uniformity of about 1% or less.
- 82. The method of Claim 76, wherein the silicon-containing compound layer has a surface roughness that is greater than the substrate roughness by about 5 Å rms or less, over a surface area of about one square micron or greater.
  - 83. The method of Claim 76, wherein the substrate comprises a step or trench.
- 84. The method of Claim 83, wherein the step has an aspect ratio of about 4.5 to 6.
- 85. The method of Claim 84, wherein the silicon nitride film has a step coverage of about 70 percent or greater.
- 86. The method of Claim 85, wherein the silicon nitride film has a step coverage of about 80 percent or greater.
  - 87. The method of Claim 83, wherein the step has an aspect ration of about 1 to 4.

- 88. The method of Claim 87, wherein the silicon nitride film has a step coverage of about 80 percent or greater.
- 89. The method of Claim 89, wherein the silicon nitride film has a step coverage of about 90 percent or greater.
- 90. The method of Claim 76, wherein the thickness of the silicon layer is between about 3 Å and 25 Å.
- 91. The method of Claim 76, wherein the reaction chamber is a single substrate laminar flow reaction chamber.
  - 92. An integrated circuit, comprising:
    an insulating layer of a silicon compound over a substrate,
    wherein the layer has a thickness non-uniformity of about 10 percent or less
    and a hydrogen concentration of less than about 2 atomic percent.
- 93. The integrated circuit of Claim 92, wherein the insulating layer comprises silicon nitride.
- 94. The integrated circuit of Claim 93, wherein a ratio of silicon and nitrogen in the insulating layer is substantially stoichiometric.
- 95. The integrated circuit of Claim 92, further comprising a crystalline silicon surface beneath the insulating layer, wherein the silicon surface is substantially free of nitrogen.
- 96. The integrated circuit of Claim 92, wherein the insulating layer comprises silicon oxide.
- 97. The integrated circuit of Claim 92, wherein the insulating layer comprises silicon oxynitride.
- 98. The integrated circuit of Claim 92, wherein the thickness non-uniformity is about 10% or less.
- 99. The integrated circuit of Claim 98, wherein the thickness non-uniformity is about 5% or less.
- 100. The integrated circuit of Claim 99, wherein the thickness non-uniformity is about 2% or less.

- 101. The integrated circuit of Claim 92, wherein the hydrogen concentration is less than about 1 atomic percent.
- 102. The integrated circuit of Claim 100, wherein the hydrogen concentration is less than about 0.5 atomic percent.
- 103. The integrated circuit of Claim 102, wherein the hydrogen concentration is less than about 0.2 atomic percent.
- 104. The integrated circuit of Claim 92, wherein a surface roughness of the insulating layer is greater than a substrate surface roughness by about 5 Å or less.